

REPORT OF NUTRITIONAL STUDIES ON THE SCREWORM
CONDUCTED AT THE SCREWORM RESEARCH LABORATORY

Mission, Texas

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by

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Dr. R. E. Gingrich and I were requested to review the nutrition of the screwworm in a memorandum from Dr. Waldemar Klassen dated Feb. 26, 1973. Dr. Gingrich and I visited the Screwworm Research Laboratory, Mission, Texas in early April 1973 and plans were made to conduct a series of experiments, to begin in the fall and lasting approximately one month. The experiments were to be designed to produce, from a laboratory diet, a fly with the "blue" color and "broad" thorax of the wild or animal-reared fly.

To assist in the experimental design, information on the composition of beef blood, amino acid content of blood and muscle, and an amino acid analysis of screwworm larvae and adults was requested. Dr. Klassen assisted in routing this request to the proper individuals so that the data were available for the experiments.

I arrived in McAllen, Texas on Oct. 28, 1973 and reported to the Screwworm Research Laboratory on Monday, Oct. 29. Dr. Gingrich was also there and after consultation with Dr. R. C. Bushland and Jack Graham, a series of experiments was planned.

The available data indicated that a "wild" type of fly had not been produced, even on the best diets of horsemeat, blood and plasma. Thus, it seemed advisable to attempt to make changes in the "best" diet to determine if it could be modified to produce a wild type fly. Examination of the experiments with horsemeat: blood: plasma diets revealed that the blood or plasma was always diluted with water by a factor of 1/3 to 1/2.

The reasons for the limitation on color, robustness, and larval size of insects from laboratory diets are not known. They may be related to the differences between "living" and "dead" tissue; such differences would be subtle, perhaps complex and difficult to determine. It was felt that a deficiency in some major component of the media, such as protein, minerals or vitamins, should be eliminated as a first step. Therefore, protein as egg albumin, 3 mineral mixtures, or a vitamin mixture were added to the 1000 ml of water and in addition, plasma was substituted for the 1000 ml of water to determine if dilution of one or all of these components determined the type of fly produced from the diets. Availability of food, the accumulation of wastes, and pH were also recognized as possible limitations on the type of fly and some experiments were designed to test these factors.

The original intention was to observe the incidence of blue flies and make some measurements of the thorax as an indication of the success of the modifications of the diet. It was soon apparent that there was considerable variation in the color and appearance in both lab and wild flies and that valid objective measurements of the differences would be difficult. Discussions with individuals associated with the Screwworm Project raised several questions about the color of wild flies and the factor(s) that make the wild fly appear more "broad shouldered" or robust. The incidence of "green" screwworm flies in nature, the size variation and the effect of premature pupation (forced by death of the host) on color and robustness of the flies are other unknowns.

Some individuals felt that there was a color change in the flies after death. This was tested by freezing some laboratory-reared flies, then holding some at room temperature, heating some at 37°C for several hours, and putting others in the sun. Those heated at 37° or exposed to the sun changed to the blue color of the wild fly. Flies which are caught in traps might be exposed to such conditions either in the trap or in the vehicle in which they are transported. Thus, an unknown number of green wild flies may change to blue in the trapping and handling process. Captured laboratory flies might also turn blue and be incorrectly identified as wild.

Dr. Bill Hightower had, in the past, made measurements of the width and length of the thorax of wild and laboratory-reared flies. The ratio of length/width from these data was found to be 1.02 ± 0.02 for 25 wild flies and 1.05 ± 0.02 for 25 lab flies. This is not statistically significant by the t test. Efforts to find specific characteristics to measure the "robust" characteristic were unsuccessful.

The robust characteristic was thought to be present, even in small wild flies which result from premature pupation. This was discussed with Mr. Calvin Jones and at his suggestion a field trip was made to the King Ranch at Encino, Texas. Larvae in the ears of cattle were obtained; a group of large larvae were forced to pupate without completing their feeding and produced pupae weighing 49 mg. This corresponds to a larval weight of wild flies of approximately 70 mg but would be slightly larger than the usual laboratory-reared larvae. A second group of larvae was about 24 hours old; these were forced into the horse meat diet where development was completed and pupae weighing 53.9 mg were produced. Mr. Jack Graham examined the adult flies from these larvae and compared them with flies that had been reared on sheep, on hydroponic diets, and horse meat diets. Only those from sheep had the appearance of wild flies. Thus, flies which had developed from larvae taken from cattle and forced to pupate prematurely or which completed a substantial portion of their larval development on laboratory diets could not be distinguished from flies reared wholly on laboratory diets. In other words, both blue and green flies were present and they did not have the robust appearance of wild flies. It was concluded that the blue color and broad thorax or robust appearance were difficult to define and were inadequate for evaluation of differences in flies from the experimental diets.

Since the original characteristics were lacking in objectivity, the following methods were selected for evaluation of the flies from the experimental diets: (1) Average larval weight as determined by the weight of 10 larvae which were selected just prior to pupation; (2) Tendency to fly-- this was a modification of a published method for determining the tendency of an insect to fly. Modification of the method, equipment, and initial testing had been done by Dr. M. M. Crystal. This method was applied to the males from each diet in the expectation that flies from the best diets might have a greater tendency to fly; (3) Stress survival-- Jack Graham had done some experiments with the survival of adult flies at 39°C. It was reasoned that survival under this type of stress would be a desirable characteristic and such flies should be found in the best

diets. In the test, 20 male flies that were 5 days old were exposed to 36°C, without food or water for 16 hours and the percent mortality recorded; (4) Categorizing by physical characteristics-- 3 technicians, experienced in the classification of wild and laboratory-reared flies, classified 20 male flies from each diet. A successful diet should show a larger percentage of flies appearing like the wild type.

Examination of the results of the evaluation tests of flies from the Group III diets suggested the possibility that the size of the flies might be a factor in survival under the stress of exposure, without food or water, to a temperature of 36° for 16 hours. Therefore, some measurements of the wet weights of survivors were made immediately at the end of the test. Measurements of the dry weights of the survivors and dead flies were made after drying to a constant weight at 36°C.

Five groups of experimental diets were set up. Each group contained a Standard diet which contained 4 ml formaldehyde, 1000 ml water, 500 ml blood plasma, and macerated horsemeat (approximately 1500 gm) for a proper consistency. Unless otherwise indicated, the changes in the diets were to modify the 1000 ml of water by adding egg albumin, minerals, vitamins or by substitution of plasma for the water.

The diets were made up on Friday afternoon and one replicate of each diet was started on Sat., Sun., and Mon. The larvae pupated in 4 days and emerged as adults in 15 days. The adults were tested when 5 days old.

The diets were:

Group I*

1. Standard
2. 0.1% Wesson salts
3. 0.1% Human blood salt mix
4. 0.1% House salt mix
5. 20 ml of Vanderzant vitamin mix

* Dr. Gingrich determined the osmotic pressure of the salts after the tests were begun and found that 0.9% was more nearly isotonic. It was also found that the vitamins were only 1/3 of that which might be required. Thus, flies from this group were used in an effort to standardize the evaluation procedures.

Group II

1. Standard
2. Undiluted plasma
3. 6% egg albumin + amino acids*
4. 6% egg albumin + amino acids, 0.1% Wesson salts, 20 ml vitamins
5. 6% egg albumin
6. 6% egg albumin + amino acids, 5% dried blood, 0.1% Wesson salts, 20 ml vitamin mix

* Selected amino acids were added to the egg albumin to make its amino acid composition more like that of bovine plasma.

Group III

1. Standard - pH not adjusted
2. Standard - pH 7.0
3. 1000 ml citrated whole blood, pH not adjusted
4. 3% egg albumin, pH 7.0
5. 3% egg albumin + Lysine and Phenylalanine*, pH 7.0
6. 3% egg albumin + Lysine and Phenylalanine*, pH not adjusted

* The "protein score" concept was used as the basis for modifying the amino acid composition of the egg albumin. The carcass analysis of larvae reared on sheep was used as the standard and lysine and phenylalanine were the most limiting amino acids.

Group IV - all diets were pH 7.0

1. Standard
2. 0.9% Wesson salt mix
3. 0.9% Human blood salt mix
4. 0.9% House salt mix
5. 60 ml Vanderzant vitamin mix
6. 3% egg albumin, 60 ml vitamin mix, 0.9% Human salt mix

Group V - all diets were pH 7.0

1. Standard
2. 6% egg albumin
3. 6% whole egg
4. 12% cottonseed flour
5. Texturized soybean protein, no horse meat, 6% egg albumin, 0.9% Human salt mix, 60 ml vitamin mix, 500 ml plasma
6. Texturized soybean protein, no horse meat, 1000 ml of a 1:1 dilution of hydroliquid, 500 ml plasma

Results

Group II Diets.-- Substitution of plasma for the water or the addition of egg albumin in the water of dilution produced slightly larger larvae (Table 1, diet 2) than did the Standard diet (Table 1, diet 1). However, they were not any larger than some larvae from the Standard diet in other groups (Table 1, Group III, diets 1 & 2; Group V, diet 1). Flies from diet 3 were the least responsive in the flight test (Table 2) and had one of the higher mortalities in response to stress (Table 3). Flies from diet 6 were most responsive in the flight test (Table 2) and had one of the lower stress mortalities (Table 3).

Group III Diets.--Adjustment of the pH to 7.0 did not make any consistent difference in larval weights, flight response, or stress response (Tables 1, 2, 3). Addition of lysine and phenylalanine to egg albumin (diets 5, 6) to correct a theoretical deficiency of these amino acids (based on amino acid analysis of the carcass of larvae which had developed on sheep) did not produce any change in larval weight (Table 1) or flight response (Table 2) but flies from this diet at pH 7.0 did have a higher stress mortality (Table 3).

Group IV Diets.--This group of diets was expected to be the most significant of those tested because the media was adjusted to pH 7.0, the concentrations of vitamins and minerals were adjusted to a more nearly correct amount than those in Group I and some modifications in the techniques to decrease waste and increase the availability of food had been made. Examination of the larval weights, flight tendency and stress response does not show any obvious differences between the Standard and the test diets.

Group V Diets.--These diets were to test the quality of different proteins. The larger larval weights in this group are attributed to the reduced number of larvae per container and the addition of plasma to make the diet more liquid during the last 24 hours of larval development. Larvae from diets 1, 2, and 3 are comparable. Diet 4 with 12% cottonseed flour (CSF) did not support growth beyond 24 hours, reduction to 6% CSF at the end of 24 hours improved growth somewhat and a further reduction to 3% CSF at the end of 48 hours permitted larvae in replicate 3 to mature. The CSF may have some value in diets at 3%. In diets 5 & 6, the texturized soybean protein was substituted for the meat and constituted approximately 50% of the diet; no development occurred on these diets.

The data were examined by plotting flight response against larval weight (Fig. 1). The data are from 18 different diets which might explain the scatter of the points. However, the distribution of the points suggest that the larger flies do have a greater tendency to fly. The use of a single diet and refinement of the flight response test should reduce the variation and confirm this observation.

The same variations from the 18 different diets are present in a plot of the stress mortality vs larval weight. This plot (Fig. 2) shows rather clearly that the mortality is less in flies from the larger larvae.

The survival value of the larger flies is further shown in a comparison of the dry weights of the survivors and dead from the stress test. At the end of the stress treatment period, the survivors were killed by crushing and then both survivors and dead were dried to a constant weight at 36° C for 24 hours and then weighed. It was found in 23 out of 29 comparisons that the survivors weigh more than those killed by the treatment (Table 4).

Miscellaneous

1. One comparison of wild flies reared on cattle with those reared in the laboratory seemed to show a different type of activity and movement. Those from the lab seemed hyperactive with movements that were jerky and excessive. There seemed to be less waste movement in the wild flies. Other observations have not confirmed this but additional observations are suggested; if the type of movement in the lab flies is confirmed, it may indicate a deficiency of thiamine and/or niacin.
2. The question of the toxicity of formaldehyde has been raised on several occasions. If it is toxic, it may be due to its formic acid content. This might be checked and if formic acid is toxic, then the formaldehyde should be stored over calcium chips.
3. It was noted that benzene is used as a killing agent in the traps. Benzene is very toxic to humans and should be used with extreme caution. It is suggested that ethyl acetate be tried as substitute.

Conclusions

The original goal of producing a wild type of fly with a blue color and robust appearance was not accomplished, but the more general goal of determining if some nutritional changes in the rearing might produce a better quality fly was realized. The results of the studies indicated (1) that the waste products from the larvae probably limits their size, (2) that the lower limit on the size of acceptable larvae should be 65-68 mg instead of the present 60 mg, and (3) that larval size and the mortality resulting from exposure of adult flies to heat stress could give laboratory data that would have a direct relationship to survival in the field and consequently the performance of the released flies in the eradication program.

Recommendations for Additional Studies

I. Stress Mortality.--The lower survival, under heat stress, of larvae that weigh less than 65 mg (Fig. 2) suggests that low survival of the released flies may have been a factor in the 1972 outbreak of screwworms in Texas.

The stress test appears to make possible the evaluation of the expected performance of the released "mass-reared" flies in the eradication program. It is suggested that first priority be given to refining and standardizing this test and relating the survival under laboratory conditions to survival in nature.

The following points of the test need to be standardized:

1. Optimum age of the fly for testing.
2. Time interval of emergence of adults.
3. Pre-treatment.
 - a. Amount of CO₂ anesthesia and recover time.
 - b. Interval between receiving food and water and the treatment.

4. Exposure temperature.
5. Length of exposure.

Relationship of survival in the lab test to that in nature might be accomplished in 2 ways: (1) Determine the survival of wild or animal-reared flies and use this data as an optimum or goal; (2) produce larvae that vary in size and determine the response of the resulting flies to laboratory stress and compare with the survival of similar flies in a standardized field cage test.

II. Nutritional Experiments. --The normal sized larvae which developed in the apparatus with horsemeat and continuously flowing plasma suggests that larval waste products limit the size of the larvae and also limits the effects of nutritional changes in the diet.

It is suggested that an effort be made to perfect an apparatus similar to that in Fig. 3 for use as a research tool. Dependable regulation of temperature and liquid flow (perhaps intermittent) through the larval medium would allow a more realistic appraisal of nutritional changes in the diet. For example, it was possible to produce 90 mg larvae with horsemeat and flowing plasma. What is the maximum size larvae that would be produced with a flow of Hydroponic fluid through the cotton linters? Such a device should be able to evaluate the quantity and quality of the ingredients in the Hydroponic diet and determine the most economical diet that would produce the best larvae because the waste products would be removed as a limiting factor. Use of such a flow-through technique would probably also reduce rearing costs by eliminating the need for removal of spent diet.

Efforts should also be made to determine what is in the waste that limits larval growth. Such information could make it possible to neutralize the wastes or remove the toxic component and reclaim the unused nutrients in the spent Hydro liquid.

Acknowledgements. --Many individuals contributed much to this research, both in actual assistance in the work and in discussions of the varied aspects of the screwworm program. Dr. Bushland, Dr. Gingrich, Jack Graham, and Frank Dutley were especially helpful in acquainting me with the screwworm program and providing basic information on the various aspects of rearing screwworms. Dr. Bushland, in addition, provided the necessary materials and facilities for the research. Thelma Jester was also helpful in securing materials and assistance. I greatly appreciate the willingness of Dr. M. M. Crystal to permit the free use of his laboratory space and equipment.

The services of Bob Handke are much appreciated. Bob was dependable in carrying out instructions, performed his duties with a minimum of instruction, anticipated the needs of the program, showed ingenuity in adapting laboratory apparatus to different needs, and he willingly worked additional hours outside the normal work schedule. I believe he is an excellent technician and should be encouraged to further increase his technical and formal training.

Table 1. Average weight^{a/} of larvae from experimental diets for the screwworm.

	Diet	Replicate			Average
		1	2	3	
<u>Group II</u>					
Standard	1	65.8		69.6	67.7
1500 plasma	2	70.4		75.4	72.9
6% EA + AA	3	72.0		70.0	71.0
6% EA + AA, WS, VM	4	68.7		63.9	66.3
6% EA	5	77.9		74.6	76.3
6% EA, WS, 5% DB, VM	6	56.0		58.1	57.1
<u>Group III</u>					
Standard, pH Na	1	72.5	70.7	65.8	69.7
Standard, pH 7.0	2	71.8	71.1	69.0	70.6
Whole blood, pH Na	3	64.0	40.3	-	-
3% EA, pH 7.0	4	72.2	69.3	66.7	69.4
3% EA+Ly, Ph, pH 7.0	5	68.9	68.6	66.7	68.1
3% EA+Ly, Ph, pH Na	6	71.4	74.0	62.7	69.4
<u>Group IV</u>					
Standard	1	66.1	72.0	65.6	67.9
0.9% WS	2	58.2	65.2	65.9	63.1
0.9% HB	3	59.5	64.7	61.9	62.0
0.9% Ho	4	60.4	68.8	65.3	64.8
VM	5	65.0	63.5	72.7	67.1
3% EA, VM, 0.9% HB	6	60.6	60.1	59.5	60.1
<u>Group V</u>					
Standard	1	74.7	77.6	74.8	75.7
6% EA	2	74.4	77.5	77.6	76.5
6% Whole egg	3	81.7	70.6	65.6	72.6
12% cottonseed flour	4	-	-	62.5	62.6
Textured soybean protein, 6% EA	5	-	-		
Tex. soybean protein, 50% Hydro.	6	-	-		

Miscellaneous

Sheep 95.0 (pupae-78 mg)

Larvae from Apparatus with Plasma Exchange

Test 1 - 68 mg vs 69.7 (larvae)(regular): 53.7 (exchange) vs 50.8 (reg.)-pupae

Test 2 - 51.5 (exchange) vs 53.5 (reg.)-pupae

Test 3 - Meat 84.8 mg Test 4 - Meat 90 mg- largest 95 mg

Test 5 - Cotton linters 50 mg

^{a/} All weights in mg.

Abbreviations: EA=egg albumin; DB=dried blood; VM=Vanderzant vitamin mix; AA=amino acids; HB=Human blood salt; WS=Wesson salt; Ho=House salt; TxMx= Tex-Mex strain of flies; Ly=lysine; Ph=phenylalanine.

Table 2. Flight tendency of 5-day-old male screwworm flies; 3 replicates of 20 males each unless indicated otherwise. (Percent responding)

Diet	Replicate			Average	
	1	2	3		
<u>Group II</u>					
Standard	1	45	33	39	
1500 plasma	2	45	32	39	
6% EA + AA	3	40	24	32	
6% EA + AA, WS, VM	4	38	32	36	
6% EA	5	37	45	41	
6% EA, WS, 5% DB, VM	6	53	48	51	
Plant		20	33	27	
Sheep		35		35	
<u>Group III</u>					
Standard, pH Na	1	47	23	30	33
Standard, pH 7.0	2	55	23	17	32
Whole blood, pH Na	3	23	-	-	-
3% EA, pH 7.0	4	51	44	23	39
3% EA+Ly, Ph, pH 7.0	5	42	42	45	43
3% EA+Ly, Ph, pH Na	6	43	48	33	41
Plant		43	27	-	35
<u>Group IV</u>					
Standard	1	20	48.4	38.4	35.6
0.9% WS	2	15	41.8	47.1	34.6
0.9% HB	3	13.3	41.8	46.7	34.1
0.9% Ho	4	30	41.8	-	35.9
VM	5	18.3	36.7	46.7	33.9
3% EA, VM, 0.9% HB	6	25	38.4	-	31.7
<u>Group V</u>					
Standard	1	22	48	36	35
6% EA	2	23	27	34	24
6% Whole egg	3	20	11	34	22
12% cottonseed flour	4				
Tex. soybean protein,					
6% EA	5				
Tex. soybean protein,					
50% Hydro.	6				

Abbreviations: EA=egg albumin; DB=dried blood; VM=Vanderzant vitamin mix; AA=amino acids; HB=Human blood salt; WS=Wesson Salt; Ho= House salt; Ly=lysine; Ph=phenylalanine.

Table 3. Mortality of 5-day-old male screwworm flies after 16 hours exposure (without food or water) to 36°C. 20 males per replicate unless indicated otherwise. (Percent mortality)

Diet	Replicate			Average
	1	2	3	
<u>Group II</u>				
Standard	1	90	35	62.5
1500 plasma	2	85	100	92.5
6% EA + AA	3	75	100	87.5
6% EA+AA, WS, VM	4	60	90	85
6% EA	5	30	89	59.5
6% EA, WS, 5% DB, VM	6	55	70	62.5
Plant		100		100
Sheep		40	55	40
<u>Group III</u>				
Standard, pH Na	1	0	60	80
Standard, pH 7.0	2	15	75	72.5
Whole blood, pH Na	3	75	-	75
3% EA, pH 7.0	4	75	85	66.7
3% EA+Ly, Ph, pH 7.0	5	90	95	93.3
3% EA+Ly, Ph, pH Na		65	75	68.3
Plant		100	90	95
<u>Group IV</u>				
Standard	1	90	100	83.3
0.9% WS	2	95	95	95
0.9% HB	3	60	85	80
0.9% Ho	4	100	100	100
VM	5	95	100	97
3% EA, VM, 0.9% HB	6	80	85	82.5
Plant-TxMx		65	40	52.5
<u>Group V</u>				
Standard	1	50	85	65
6% EA	2	45	75	50
6% Whole egg	3	20	65	48
12% cottonseed flour	4		65	65
Tex. soybean protein, 6% EA	5			
Tex. soybean protein, 50% Hydro.	6			
Plant-TxMx		40	65	56.6

Abbreviations: EA=egg albumin; DB=dried blood; VM=Vanderzant vitamin mix; AA=amino acids; HB=Human blood salt; WS=Wesson salt; Ho=House salt; Ly=lysine; Ph=phenylalanine.

Table 4. Dry weights of flies that survived and died from heat stress.
(Weights in mg)

Diet	Replicate							
	1		2		3		Average	
	surv.	dead	surv.	dead	surv.	dead	surv.	dead
<u>Group III</u>								
1 Standard, pH Na					9.5	9.1		
2 Standard, pH 7.0					10.7	8.8		
3 Whole blood, pH Na								
4 3% EA, pH 7.0					10.2	10.0		
5 3% EA+Ly, Ph, pH 7.0					10.3	8.9		
6 3% EA+Ly, Ph, pH Na					9.0	9.3		
Average					9.9	9.2		
<u>Group IV</u>								
1 Standard	9.9	9.1		9.9	9.9	9.4	9.9	9.3
2 0.9% WS	9.0	8.2	8.7	8.3	9.0	8.7	8.9	8.4
3 0.9% HB	8.5	8.0	8.6	8.8	8.0	8.5	8.4	8.4
4 0.9% Ho	-	7.8		9.3		9.0		
5 VM	9.7	8.7		9.0		10.0	9.7	8.7
6 3% EA, VM, 0.9% HB	8.7	8.9		9.1			8.7	8.9
Plant(TxMx)	8.7	8.5	9.3	8.4				
Average	9.1	8.4*	8.7	8.5*	9.0	8.9*	9.1	8.7
<u>Group V</u>								
1 Standard	11.2	10.1	13.1	11.1	11.2	10.9	11.8	10.7
2 6% EA	11.4	10.8		10.4	11.1	11.3	11.3	11.1
3 6% whole egg	12.2	11.4		9.6	11.5	10.8	11.9	11.1
4 12% cottonseed flour					9.7	9.0		
5 Tex. soybean pro- tein, 6% EA								
6 Tex. soybean pro- tein, 50% Hydro.								
TxMx	9.0	8.2	9.5	8.1	9.6	8.0	9.4	8.1
Average	11.0	10.1	13.1	9.8	10.6	10.0	11.1	10.3

Abbreviations: EA=egg albumin; DB= dried blood; VM= Vanderzant vitamin mix;
AA= amino acids; HB=Human blood salt; WS=Wesson salt; Ho=House salt;
Ly=lysine; Ph=phenylalanine; TxMx=Tex-Mex strain of flies.

* Averages do not include values where 100% mortality occurred.

Table 5. The weight of male flies that survived heat stress. (Weights in mg)

Diet	Replicate			Average
	1	2	3	
<u>Group IV</u>				
1 Standard	29.1	-	22.1	25.6
2 0.9% WS	26.9	25.8	27.6	26.8
3 0.9% HB	23.1	24.8	22.7	23.5
4 0.9% Ho	-	-	-	-
5 VM	25.1			25.1
6 3% EA, VM, 0.9% HB	25.6	25.2		25.4
Plant-TxMx	23.2	25.1		24.1
Average	25.5	25.2	24.1	25.1
<u>Group V</u>				
1 Standard	33.5	37.6		35.6
2 6% EA	33.9	29.9		31.9
3 6% whole egg	35.2	30.6		32.9
4 12% cottonseed flour				
5 Tex. soybean protein, 6% EA				
6 Tex. soybean protein, 50% Hydro.				
Plant TxMx	25.0	26.8		
Average	31.9	31.2		33.5

Abbreviations: EA=egg albumin; DB=dried blood; VM=Vanderzant vitamin mix; AA=amino acids; HB=Human blood salt; WS=Wesson salt; TxMx=Tex-Mex strain of flies; Ho=House salt.

Table 6. Comparison of larval weight, stress mortality, and flight response of flies from four different sources.

Source	No. of replicate	Avg. larval weight (mg)	Stress % mortality	Flight % response
Sheep - Florida strain	2	95	53	35
Horsemeat standard- Florida strain	12	70.2	70	62
Hydroponic - APHIS	3	61 *	97	31
Hydroponic - TxMx	5	61 *	55	-

* Average weight of flies being produced by the Rearing Plant at the time the tests were conducted.

FIG. 1 FLIGHT RESPONSE OF ADULT FLIES IN RELATION TO LARVAL WEIGHT

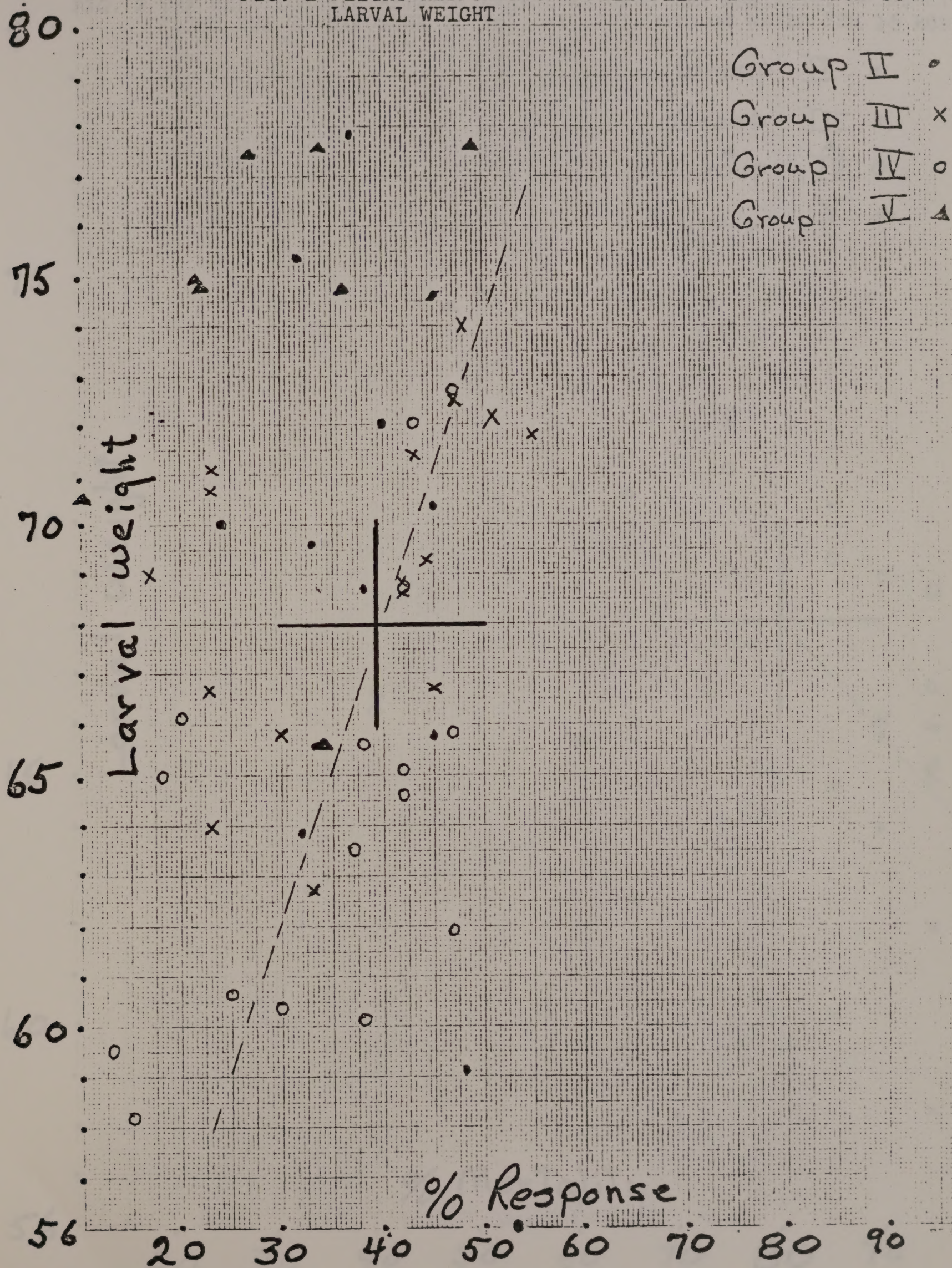


FIG. 2 THE RELATIONSHIP BETWEEN LARVAL WEIGHTS AND MORTALITY OF ADULT FLIES DUE TO EXPOSURE TO 36°, WITHOUT FOOD OR WATER FOR 16 HOURS

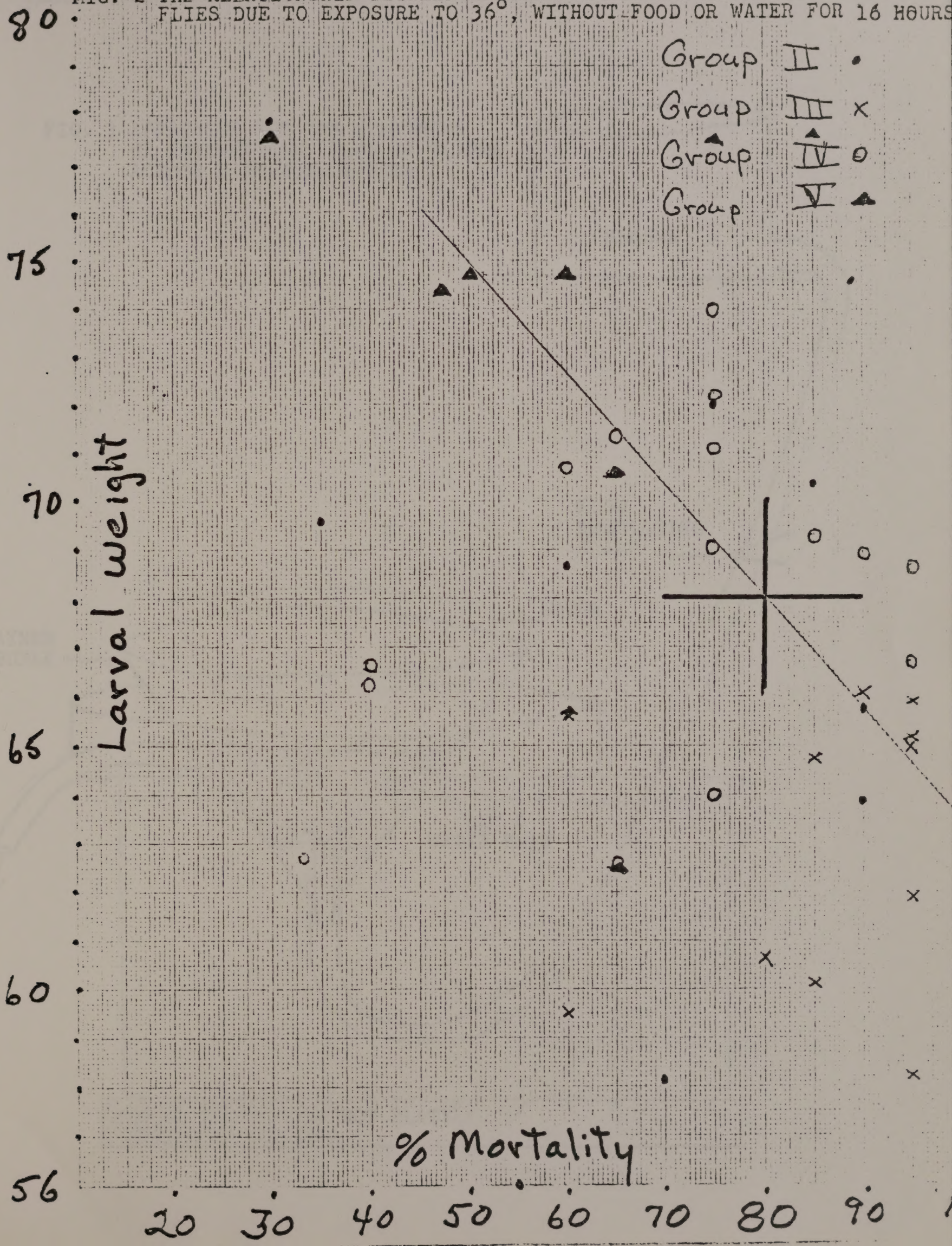
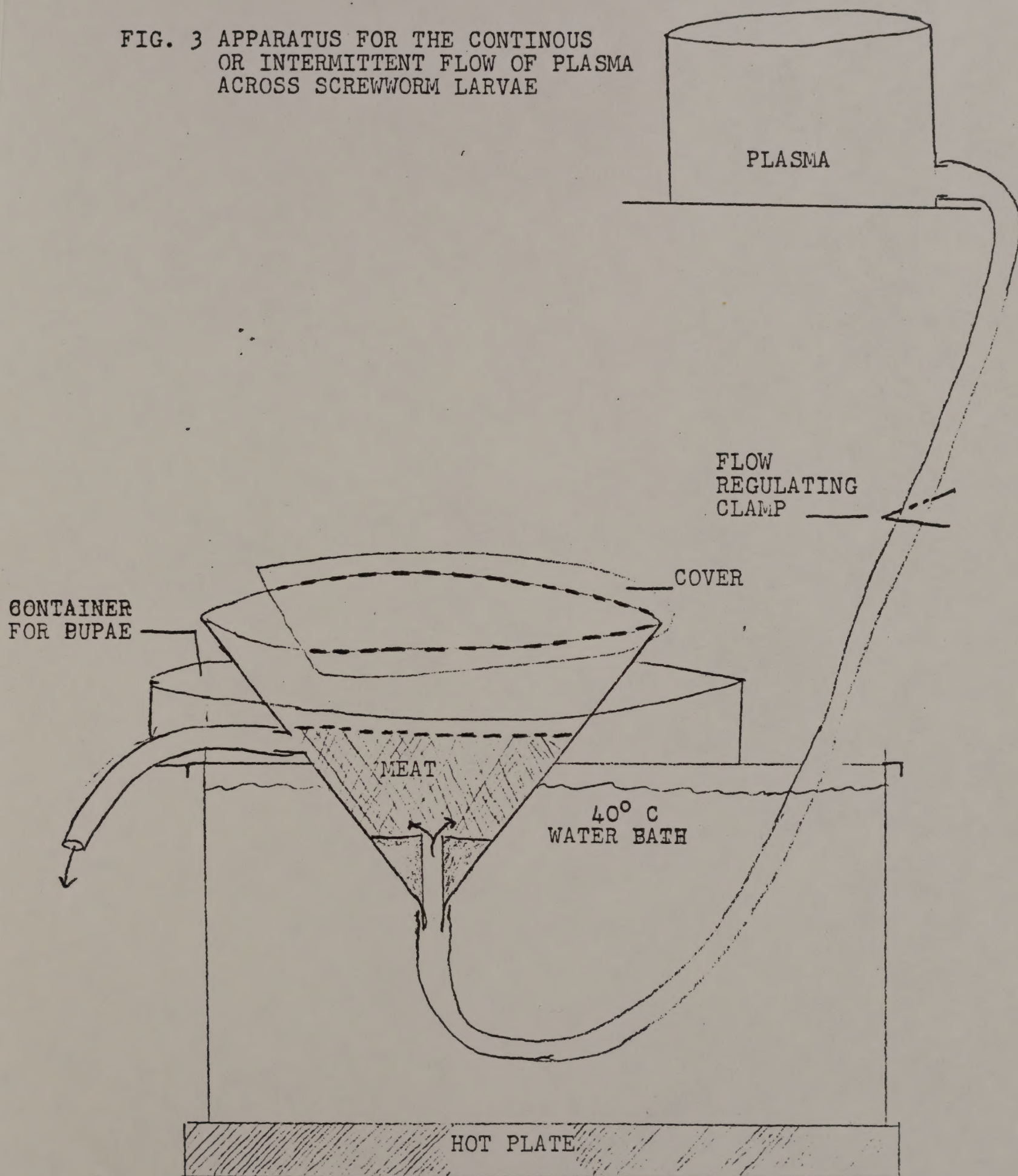


FIG. 3 APPARATUS FOR THE CONTINUOUS
OR INTERMITTENT FLOW OF PLASMA
ACROSS SCREWORM LARVAE





United States
Department of
Agriculture

Agricultural
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Service

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February 3, 1983

SUBJECT: 1973 Report on Screwworm Nutrition Research

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The subject report is enclosed.

The information on response to heat stress is in Tables 3 and 6, and figure 2. The mortality on naturally-reared flies from sheep is in Table 3, Group II. The comparison in weight and stress between strains is in Table 6. Figure 2 shows a trend to lower mortality in larvae that weight more than 68 mg. Those from sheep at an average of 95 mg would be off the graph.

I hope this will be useful. Please call me if you have any questions.

R. F. Moore

R. F. MOORE
Research Leader

Enclosure

2/8
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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Southern Region
Georgia -South Carolina Area
Southeastern Cotton Insects Investigations
P. O. Box 271, Florence, S. C. 29501

January 9, 1974

Subject: Report of Nutritional Research Conducted on Screwworm,
Oct. 29, 1973 to Dec. 12, 1973, at Mission, Texas

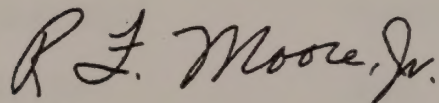
To:	W. M. Bruce, Tifton, Ga.	Lyman Henderson, Beltsville, Md.
	R. C. Bushland, Mission, Tex.	Chris Hoffman, Mission, Tex.
	E. Corristan, Mission, Tex.	C. H. Hoffman, Beltsville, Md.
	M. M. Crystal, Mission, Tex.	W. Klassen, Beltsville, Md.
	H C Cox, New Orleans, La.	E. F. Knipling, Beltsville, Md.
	R. E. Gingrich, Kerrville, Tex.	M. E. Meadows, Mission, Tex.
	Jack Graham, Mission, Tex.	E. A. Taylor, Weslaco, Tex.

Through: H. M. Taft, Research Leader

The subject report is the result of research conducted during a temporary assignment to the Screwworm Research Laboratory, Mission, Texas.

The original goal of producing a wild type of fly with a blue color and robust appearance was not accomplished, but the more general goal of determining if some nutritional changes in the rearing might produce a better quality fly was realized. The results of the studies indicated (1) that the waste products from the larvae probably limits their size, (2) that the lower limits on the size of acceptable larvae should be 65-68 mg instead of the present 60 mg, and (3) that larval size and the mortality resulting from exposure of adult flies to heat stress could give laboratory data that would have a direct relationship to survival in the field and consequently the performance of the released flies in the eradication program.

Some additional experiments will be conducted in January and February 1974 to complete portions of the studies.



R. F. Moore, Jr.
Research Entomologist

